Surrogate Neutron-induced Reaction Cross Section Measurements using STARS

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Reactions on unstable nuclei are at the core of nucleosynthesis in environments from stars to supernovae to the interior of nuclear weapons. However, the cross sections for many of these reactions are difficult to predict due to the presence of nuclear structure effects and unusual decay modes, and equally difficult to measure due to the short lifetimes of the radioactive species involved. The LLNL group is leading an effort to deduce these cross sections using a technique referred to as the surrogate reaction method. The surrogate method involves measuring the particle and g-ray decay probabilities of highly excited nuclei with a well-defined excitation energy and spin distribution populated via a transfer reaction. These measured probabilities can then be combined with neutron optical model calculations to produce equivalent neutron-induced reaction cross sections. In this talk I will present results from two experiments using the surrogate reaction technique. The first experiment used the STARS (Silicon Telescope Array for Reaction Studies) spectrometer coupled to GAMMASPHERE to successfully reproduce surrogate (n,γ), (n,n') and (n,2n) cross sections on ^{156,155}Gd using ^{3}He-induced reactions. The second experiment performed at the Wright Nuclear Structure Lab at Yale University using STARS coupled to the YRAST ball g-ray array used 3He-induced reactions as surrogates for the ^{90,91}Zr(n,xγ) reactions. The results from this experiment will be compared to recent work by Garrett et al., where ^{90}Zr(n,xn yp z$\alpha\gamma$ reactions were measured using the GEANIE spectrometer [1]. This experiment is of particular interest since the population of discrete states in the residual nuclei populated using ^{3}He and neutrons can be compared providing insight into spin differences between the two reactions. The implications of this data for the surrogate reaction technique will be presented and competition between equilibrium and pre-equilibrium reaction modes discussed.

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